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ATIC BULLETIN

AEROSPACE TECHNICAL INTELLIGENCE CENTER

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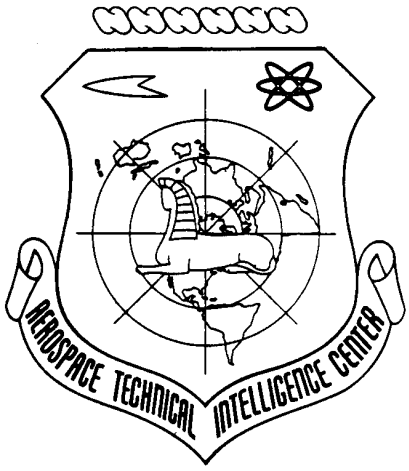

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NOTE

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1. (U) GUIDANCE SYSTEMS FOR SOVIET AIR-TO-SURFACE MISSILES

Mr. D. D. Notestine

ATIC has estimated the guidance-system characteristics and capabilities of Soviet air-to-surface missiles having ranges of 55, 100, 350, and 500-1000 NM. The estimates are based on information from all available sources, known mission requirements, and established Soviet practices.

The guidance system estimates for the various classes of air-to-surface missiles are shown in Table I on page 4.

Equipment Descriptions

(1) Beam Rider with Semi-Active Radar Homing.

A beam rider with semi-active radar homing guidance system is estimated for the 55-NM air-to-surface missile. The missile rides a radar beam for the first two-thirds of its flight, and then with semi-active radar homes on the target. The control switches when the field strength of the received echo from the target reaches a pre-set value. A pulsed X-band radar in the launching aircraft provides both the energy for beam-riding and target illumination for semi-active homing. Thus, it is necessary that the radar beam be directed at the target throughout the missile flight.

(2) Inertial Guidance With Active Radar Homing.

An inertial guidance system is estimated for the 100 and 350-NM air-to-surface missiles used against stationary targets. For strikes against ships at sea, an active radar will also be employed in the missile for terminal guidance to the target.

The navigation system of the launching aircraft aligns the inertial equipment and provides initial position to the guidance computer prior to launch. After launch, the computer integrates acceleration data from the inertial equipment to determine missile position. Computed values are then compared with programmed target data to obtain guidance signals for the flight-control system.

When terminal homing is used against ship targets, the active radar locks on the target and takes over guidance of the missile. The missile-borne radar is estimated to be capable of target acquisition at 50-NM range against a 100-square-meter ship target.

2. (U) NEW, HIGH-PERFORMANCE SOVIET GLIDERS

Mr. J. L. Rohn

During 1960 a number of Soviet publications revealed the existence of a new, high-performance Soviet glider. This single-seat all-metal glider reportedly was constructed under the supervision of the renowned aircraft designer O. K. Antonov and it reflects a high degree of aerodynamic refinement. It is designated the A-15.

Sport-type gliders normally have little military or intelligence value, but this is the third significant glider development by the Antonov Design Bureau in as many years and indicates the advanced capability of the design bureau. Statements such as "The world's sportsmen have never seen such gliders as the A-15" (by test pilot S. A. Anokhin, who has flown gliders for over thirty years) have been published. Moreover, the data released on the A-15 discloses that lift/drag ratios have been improved to the extent that the developments probably will be applied to larger aircraft.

On 6 May 1960, a Moscow broadcast stated that the A-15 has a glide ratio of 42 to one. Since the glide ratio of a glider directly indicates the lift/drag ratio, this value of 42 for the A-15 glider is exceptional. The glide ratio of the best high-performance gliders has been between 25-32 when the lift had been improved and the drag reduced as much as practicable. On one design, however, the late Dr. August Raspet of Mississippi State College achieved a glide ratio of 55 through a remarkable effort in the reduction of drag, utilization of a laminar-flow airfoil, and employment of boundary-layer control. Thus, the glide ratio on the A-15 glider is considerably better than all previous glider designs, other than the one outstanding effort, and it probably was achieved by methods similar to Raspet's.

It became evident that the glide ratio claimed is approximately correct when it was announced that the A-15 glider had established two new World Records. The Moscow News, on 22 June 1960, said that the A-15 has been flown around a triangular closed course of 100 km at an average speed of 111.388 kmh (60 knots). This speed surpasses the 1959 US record of 107.040 kmh, the Yugoslavian record of 97.066 kmh and the USSR record of 77.144 kmh. The flight was made by Mikhail Veretennikov in May 1960. He was towed by a Yak-14 (CROW) light transport to 700-800 meters (8200 ft) altitude, and flew from Suma City to Ulyanovka to Mikhylovka and back to Suma. In June 1960, the same pilot and glider made a 714 km (385 NM) "goal" flight (flight to a pre-determined destination) in eight hours, bettering the 1956 French record by 23 km.

In October, Isvestia disclosed that the A-15 had a "remote pilot system." This system is identified as a two-way radio (transceiver) having a range of 90 km (almost 50 NM), which operates with a responder beacon. The system uses coded signals from a ground radar and from the aircraft response

the location, distance, altitude, and speed of the glider can be determined. This transceiver reportedly was especially developed for this glider, because available sets weighed 30-40 kg (66-88 lb). It uses "rod tubes" developed by Andeyev, a corresponding member of the USSR Academy of Sciences; these tubes are said to be economical, light, small, and able to withstand high overload and vibration.

The oxygen system of the A-15 is a standard Soviet aircraft system having a two-liter tank with 150-atmosphere pressure; it is effective to an altitude of 12,000 meters (40,000 ft). A water ballast system, comprising two 25-liter (6.6 US gal) tanks in the wings, permits the glider to fly faster under strong lift conditions; during weak-lift conditions the water can be jettisonned to obtain a lower wing-loading. The glider is also equipped with a retractable undercarriage, airbrakes and a "thermo-visor" to assist the pilot in locating upward-moving air currents.

The same design bureau previously had developed the two-place A-11 and the single-place A-13 glider designs (see ATIC BULLETIN, 30 May 58, Item 3). Both of these were also of all-metal construction, and production was initiated in mid-1958 under contract to the DOSAAF Central Committee. The two were identical except for the seating and the wing unit, the A-11 having a larger span designed for long-distance flights and the A-13 having a somewhat smaller span more suitable for aerobatics. The Soviet newspaper "Pravda Ukrainy" (22 June 1958) reported that both gliders were designed and constructed under the supervision of A. Yu. Monotskov from the design office of O. K. Antonov. (One Alexander Yurievich Monotskov attained recognition in 1954 when he modified one of Antonov's A-9 gliders into the flapping-wing "Kashuk"). According to one report both the A-11 and A-13 are stable and are exceptionally maneuverable gliders. Both are described as cantilever, mid-wing monoplanes with tapered wings having a single main spar and auxiliary front spar. Both versions have "plate brakes," reinforced skin fuselages, V-tails, and single-wheel retractable landing gear aided by a skid. The A-11 also has lift flaps.

Following is the available technical data concerning the A-11, the A-13 and the A-15.

	A-11	A-13	A-15
Wing Span	16.5 m (55 ft)	12.1 m (40 ft)	17 m (56 ft)
Length	6 m (20 ft)	6 m (20 ft)	7 m (23 ft)
Wing area	12.15 m^2 (130 ft^2)	10.44 m^2 (112 ft^2)	- - - - - - - -
Net weight	310 kg (680 lb)	270 kg (600 lb)	- - - - - - - -
Gross weight	400 kg (880 lb)	360 kg (800 lb)	400 kg (880 lb)
Wing loading	33 *ksm (78 psf)	35 *ksm (82 psf)	- - - - - - - -
Towing speed	- - - - - - - - - -	250 kmh (135 kn)	- - - - - - - -
Max dive speed	300 kmh (162 kn)	400 kmh (215 kn)	250 kmh (135 kn)

*Kilograms per square meter.

Attesting to the quality of these newer gliders, an A-10 (two-place version of the A-9) set a World Record for a goal flight on the same day that the A-15 set the single-place goal flight record. The A-10 with a passenger aboard, flew 600 km (325 NM) which was 58 km more than the previous record set by a Polish pilot, but more than 100 km less than the A-15 single-place record flight. (AFCIN-4F2) (The over-all classification of this item is CONFIDENTIAL.) (Releasable to UK, Can, Aus, NZ, and NATO.)

3. (U) SOVIET VLF NAVIGATION SYSTEM
Mr. L. S. Peterson

Preliminary analysis of recent Soviet VLF signals indicates that a new navigation system is in the early stages of development. The signals originate from three separate 10 to 15-kc transmitters located in the southwest part of the Soviet Union; the signals are sporadic and unstable. ATIC previously believed that the signals were sufficiently stable to be used as a VLF hyperbolic navigation system, similar to one being developed in the US. The 10 to 15-kc signals from the three existing transmitters must be stable and phase-locked to position accurately missiles or missile-launching submarines or aircraft. Signals emanating from phase-locked systems can provide navigation fixes accurate to within ±1 NM at ranges of 5000 NM.

Until these signals exhibit stable characteristics, this cannot be considered an effective navigation system. (AFCIN-4E1) (The over-all classification of this item is SECRET.) (Releasable to UK, Can, Aus, NZ, and NATO.)

FEATURE

(U) ELECTRIC EXPLOSIONS IN THE USSR

Maj P. J. Wolf

Electric explosions, underwater lightning, and electrohydraulic effect, are all Soviet terms for the same phenomenon. While it is endless in application, in essence it is simple, consisting of the discharge of a large, high voltage electrical current between two electrodes through a thin wire or through a fluid. When such discharge occurs, it results in a brilliant flash of light, a loud noise, and a shock wave of considerable magnitude, which can be harnessed to do useful work. It also radiates heat, light, electromagnetic waves, X-rays, and possibly other forms of radiation.

In behavior and effect, it is very much like the detonation of explosives, but it can be better controlled and manipulated.

While some electrical discharges such as occur in lightning or a spark plug are quite common, it is difficult to conceive the magnitude of the reaction when large amounts of energy are pumped through a restricted channel in a brief period of time. It may be helpful to consider that one discharge at a US facility produced pumping energy at the rate of 22,000,000 horsepower. This was accomplished by pumping up a large capacitor bank (200 capacitors at 7 1/2 micro-farads each) to 20,000 volts and suddenly discharging the stored energy in 10 millionths of a second. When such a discharge is passed through a thin wire in air, the wire is instantly vaporized in a brillant flash and with a loud report. In water, the shock is considerably intensified, possibly because the plasma channel that is formed cannot expand fast enough due to the relative incompressibility of water. This results in much higher temperatures and pressures. Some idea of the severity of the shock can be deduced from the fact that an open-topped tank of water weighing ten tons jumps six inches off the floor every time a discharge is made within it.

Credit for the practical exploitation of this phenomenon apparently belongs to Lev Yutkin of Leningrad Polytechnic Institute who was discussed in the article that triggered ATIC's interest in this field in mid-1958. The article discussed a new rock crushing process, but it was apparent that the shock waves developed might be even a better way of forming of space age materials than explosive forming, which was then a much discussed idea. A search of available information soon showed that Yutkin had been active in this field since his student days in 1938, when he accidentally shattered a vessel while experimenting with high voltage currents. In 1955, he published a book which listed some 150 practical applications and discussed in detail the following salient points:

(1) The basic concept and arrangement of the apparatus.

(2) The limitations of the process.

(3) Applications in such diverse fields as the forming of metals, pumping of liquids, propulsion devices, surface hardening of metals, production of fine metal powders, unusual chemical reactions, and many more.

(4) The existence of a compact practical means of repetitive shocking.

One of Yutkin's earliest applications was a rock drill with phenomenal performance. It allegedly could bore a 1 1/2-inch hole 50 feet into solid rock in one hour using 650 watts of power. While rock drills are of little consequence to air weapons, they supply evidence of the ability to produce a continuing succession of electrical shocks.

Further study of this subject shows that the Soviets applied their repetitive shocking capability to drive an extrusion press prior to 1958. In 1960, a patent was issued for presses up to 100,000 tons using this principle. The largest US extrusion press is 14,000 tons and uses regular hydraulic pumps. The press covered in the Soviet patent is stated to be for the production of one piece, "internally ribbed tubes," suggestive of Titan-type structures. The size of the tubes is not specified, but if such a 100,000-ton press does exist, it would be easily capable of producing tubes large enough for ICBMs. The persons associated with this Soviet patent are high level, technically competent individuals.

The Soviets have apparently found many other practical applications for this phenomenon; among these are metal forming, heat treatment, high pressure pumping for liquids and liquid metals, and novel chemical reactions. The latter is illustrated by the fact that an electrical discharge between electrodes placed in a container filled with kerosene will precipitate elemental carbon out of the hydrocarbon molecules. The process is also used to produce improved polymers.

The story of Yutkin seems to be one of a practical experimenter with an obsession about using electrical energy to do work directly, rather than applying it through relatively inefficient electric motors, magnets, or other transducers. He apparently worked for years at LPI, essentially unnoticed and probably on a minimum budget, developing a number of successful applications for his idea. These developments have been picked up by such prominent organizations as Tsniitmash (Central Scientific Institute for Technology and Machine Building) and after pilot plant tryouts designed into usable production equipment.

Yutkin also attracted the attention of the Academy of Sciences in 1955, when one of the members reviewed his work, praised him highly, and predicted a great future for this field. Literature concerning this leaves the

impression that the Academy judged this work to have such merit that it warranted a broad program of research by high level scientists aimed at understanding and further exploiting the phenomenon.

From this point in time, prominent physicists started doing research in this field. Among the better known are the following:

(1) Dr. Peter L. Kapitza -- Head of the Institute of Physical Problems, Moscow.

(2) Major General G. I. Pokrovsky -- Physicist, active in Soviet missile and space program.

(3) Dr. G. I. Babat -- Head of the Institute of Energetics, Moscow.

(4) Dr. K. P. Stanyukovich -- Head of Mathematics, MVTU.

(5) A. S. Zingerman -- Chair of Electro Technology, Institute of Civil Engineers.

It is obvious from the positions and backgrounds of these people, as well as from the nature of their research, that their efforts are not directed at metal-working problems. Instead, it would appear that a group of high caliber scientists who are associated in various ways with missile and space activity are working on a coordinated program involving the electrohydraulic effect, ball lightning, and magneto gas dynamics. Kapitza and Babat have both been extremely interested in ball lightning and are rumored to be working on a missile defense system involving the electrohydraulic effect. Yutkin is alleged to have developed a ball lightning projector in his laboratory. It could be most significant that Babat was "accidentally killed" while Khrushchev was in the US intent on producing some technological surprise which fizzled. No further details on Babat's death were given. Rocket Marshal Nedelin was also "accidentally killed" during the same week.

Very little information is available on Soviet weapons applications of this phenomenon; for this reason, some US unclassified work was reviewed to obtain clues to the ultimate Soviet applications. The review presents a picture in the US very similar to Yutkin's earliest years, with minimum budgets and, in some cases, bootleg research. Much of the current US effort stems from a report on Soviet activity made to some segments of US industry by ATIC in November, 1958.

Despite a late start and a low level of effort, the US has now developed the process to a point where air weapon hardware can be formed by electric explosions. Most of the applications the Soviets have mentioned, however, remain unexplored. The three principal companies involved are Convair, Ft. Worth; Chrysler Missile Division; and Republic Aviation Corporation.

Some US work was accomplished by isolated researchers, but it was of the small (1/2 inch) exploding wire type, and it had little practical application. (Chrysler can now explode 40 feet of wire in one shot and has formed a 42-inch-diameter missile bulkhead.)

In formulating probable Soviet applications of this process, US industrial thinking was used as a guide. With metal working already established, thoughts are now being given to other industrial and chemical applications. Other possibilities are long range sonar for submarine detection and possibly propulsion systems. Also being considered are destructive devices of various sorts. Chrysler claims to have vaporized a beer can at a moderate distance from the power source and also to have vaporized a rifle bullet traveling at 3000 ft/sec.

In summary, thanks to Yutkin, the Soviets have led for some time in practical applications of the electrohydraulic effect. It appears that this phenomenon has received continuing high level Soviet scientific attention since 1955 and that results commensurate with that effort can be expected. Probably their early development of a means of repetitive shocking opened up many more fruitful areas of research than was the case in the US. On the other hand, US effort has been limited, but has demonstrated that this phenomenon can be harnessed for useful and sometimes startling results. (AFCIN-4E2) (The over-all classification of this item is SECRET.) (Releasable to UK, Can, Aus, and NZ.)

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